the flood stage there, was reached on May 25 and the water remained above that point until July 14, a period of 50 days. It was above the 20-foot stage for over a month, which meant that nearly all the basements in the business district were wholly or partially inundated during that time, except where pumps were employed to keep them dry. The highest stage recorded was 24 feet on the evening of June 8, just equaling the maximum stage of the flood of 1903.

The industries in the city of Portland which were chiefly affected were the warehouse and dock interests along the water front, and the wholesale and retail houses which depended on their basements for storage or other purposes. These interests were in close touch with the local office of the Weather Bureau and received advice which enabled them to act intelligently in moving their merchandise to safer levels. Telegraph and telephone companies sustained some losses, chiefly to pole lines along the river. The underground system of the electric company was somewhat interfered with, but the loss in this direction was only nominal.

The heaviest financial losses occurred outside the city and were sustained by the railroads operating along the Columbia River and by the Columbia River fisheries. The latter are put to considerable expense each year repairing their fish wheels which have been damaged by drift material, but their main loss is less direct and not so easily estimated. It is involved in the loss of pack occasioned by the discontinuance of fish wheels, seines, and traps, for when the river is rising rapidly there is so much drift that none of these appliances can operate, and gill net fishermen are interfered with similarly.

Those depending on farm land and pasturage at low elevations are prepared to experience some loss each year from high water. Their loss is principally the loss of crops and the use of their cows, since the proceeds from the sale of milk and cream go to the party looking after the stock, when the owners themselves have no high land to pasture them on. Money loss from destroyed crops was large in many localities this year, but this may be offset to some extent by the crop planted after the flood.

Flood predictions were issued twice daily at the Weather Bureau office in Portland, and were given wide distribution by means of the weather map, the daily press, and the telephone. The circulation of the daily weather map was almost doubled during the time of high water, and the telephone was in such constant use that an employee was detailed for a time to the exclusive duty of answering calls. The forecasts were quite accurate and gave general satisfaction.

An interesting attempt to deduce a formula for forecasting river stages at The Dalles one day in advance from stages recorded at Lewiston, Idaho, on the Snake River, and at Wenatchee, Wash., on the Columbia, has been made by engineers in the United States Geological Survey. It is based on the assumption that an increase of 1 foot in gage height gives an increase in discharge of 12,000 second-feet at Wenatchee and 18,000 second-feet at Lewiston and at The Dalles.

Statistics of estimated money loss from flood and amount saved by timely flood warnings.

(1) Money value of property destroyed, or amount of damages, including railroads and excluding crops.....	$107,388.47
(2) Money value of crops destroyed or amount of damage.	92,645.00
(3) Money value of losses occasioned by enforced suspension of business through flood, including wages of employees	91,220.00
(4) Cost of removing or protecting goods in flooded basements and warehouses (in city of Portland)	4,321.00
(5) Money value of property saved by flood warnings of the Weather Bureau.....	101,370.00

FLOOD AT BOISE, IDAHO.

By EDWARD L. WELLS, Section Director.

On the afternoon of July 24, 1913, there occurred a most unusual flood at Boise. The city is situated on the river bottom, which slopes gently from the foothills of the Boise Mountains to the Boise River. Most of the gulches opening from the hills adjacent to the city are dry, except when the snow is melting or when unusual precipitation occurs. Hulls Gulch naturally carried a small flow of water, but most of this has been diverted to contribute to the water supply of the city and of the military post. The water coming down this gulch originally found its way to the river, over the surface, by a rather poorly defined channel, the course of which changed frequently, owing to the heavy deposit of sand carried. In recent years the small remaining flow has been confined in a wooden flume for several blocks and has then been turned into the sewer.

The latter part of July and fore part of August usually pass without the occurrence of any considerable amount of rain at Boise. The normal amount for the period from July 17 to August 11, inclusive, is but 0.08 of an inch. On July 23, 1913, rain began in the afternoon and from that time until the evening of the 26th showers were of frequent occurrence. On the 24th rain fell almost continuously from 6.25 a. m. until after midnight. At 2.42 p. m. the intensity of the rainfall suddenly increased and in the next 7 minutes 0.13 of an inch of rain fell. After the heavy rain was over in the city the shower could be seen passing over the hills to the northeast of the city. About 3.45 p. m. the water began to flow out of Hulls Gulch in such quantities that the flume was no longer sufficient to carry it, and in a few minutes the water came over the dam at the head of the flume and overspread that part of the city. An area approximately three blocks wide and extending from the mouth of Hulls Gulch to Fairview Addition was more or less seriously flooded. Cellars were filled with water and lawns were covered with sediment. The damage was worst above the Perrault Canal, where water entered many houses and many lawns were ruined. The flow ceased almost as suddenly as it had begun, and by 6.30 p. m. the water had receded from most of the flooded district.

Later in the evening the writer made a short trip up the gulch, locating the high-water marks and ascertaining that practically the entire flow had come from above the upper reservoir of the Boise Artesian Hot & Cold Water Co., which is about 1 mile above the mouth of the gulch.

On the afternoon of the 26th the writer walked over the greater part of the watershed, to note the effects of the storm. The entire watershed above the reservoir showed evidence of heavy precipitation, but there was no evidence o any particularly heavy downpour in any one place. The erosion was greatest about 4 miles above the mouth of the gulch, but this was probably due to the steep pitch and sandy nature of the soil in that section. That a great quantity of water had fallen was evidenced by the fact that pools were standing practically on the tops of the ridges, and even the crowns of the ridges bore marks of running water.

On the afternoon of the 29th Mr. J. B. Marcellus, deputy city engineer, took measurements from which to compute the flow of water. His report follows:

In company with Edward L. Wells, section director of the Weather Bureau, we attempted an approximation of the quantity of water that came down Hulls Gulch, due to an extremely heavy downpour of rain on the afternoon of July 24.

We went up the gulch to where the water was confined to a channel approximately 56 feet wide, and the point of cross section was taken

directly opposite of what is called Frank Eastman Park, and about 1,000 or 1,500 feet above the Boise Artesian Hot & Cold Water Co.'s (middle) reservoir. The channel at this point is fairly regular and nearly straight for about 1,000 feet. We took the cross section with an 18-inch Y level and found the bottom to be practically level. The high-water marks were determined by the wash indicated in the nearly perpendicular side of the channel, and were indicated by slight demarcations and the deposit of slight débris. The channel at this point is practically entirely in sand, although some bowlders, up to 6 or 8 inches in diameter, show in the bottom, about half bedded.

That the velocity must have been very great is indicated by a stone about 2 feet long by 8 inches square, which evidently had been washed down by the water. The amount of water running into the channel can not be determined with any degree of accuracy, and the results which we obtained are to be taken only as an approximation.

The width of the channel, as stated, was 56 feet, and the average depth of water 5.1 feet, so that the water area was 285.6 square feet. A very uniform grade of 3 feet per hundred, or 1 foot in 33⅓, was found. Using n=35, in Kutter's formula gives a velocity of 19.9 feet per second, and a quantity of 5,712 cubic feet per second. Using n=40 feet in Kutter's formula gives a velocity of 17.4 feet per second, and a quantity of 4,998 cubic feet per second.

The values of "n" were taken from Hand Books of Trautwine, Frye, and Merriam. Trautwine says: "n should be taken as 30 in canals in bad order and regimen and strewn with detritus." Frye says: "n=35 for canals and rivers in bad order with great quantities of stones and weeds, and use n=40 for rivers in extremely bad condition." Merriam says: "Use n=35 in channels in gravel in bad condition, strewn with stones and detritus." Thus the use of n=35 can be construed as fairly accurate, and n=40 as conservative.

The streets in the north end of town, which were flooded, are nearly all 60 feet wide, and if five streets were flooded to a depth of 1 foot the quantity of water would be nearly the same as that found by the measurements indicated above.

Inquiry as to the time of beginning and ending of the flood leads to the conclusion that it was nearly at its maximum height for approximately 45 minutes, after which it suddenly receded. It is believed that an estimate of 5,000 cubic feet per second for a period of 40 minutes would be fairly representative of the total amount of water. This would make 12,000,000 cubic feet, or 275 acre-feet. The area of the watershed above the upper reservoir is approximately 5 square miles, hence the run-off would represent an average rainfall over the watershed of 1.05 inches. Mr. Clyde Baldwin, in charge of the Water Resources Branch of the United States Geological Survey in Idaho, estimates that for such a heavy rain on so steep a slope as is found over most of the Hulls Gulch watershed the run-off would be 50 per cent of the total rainfall. This would give an average rainfall over the watershed of 2.10 inches.

The adjacent gulches discharged a considerable amount of water, but not sufficient to cause serious damage, hence it is probable that the heavy portion of the storm was confined to the Hulls Gulch watershed. This being true, it is probable that part of the watershed received more than the average amount, while other parts would receive less. There is, however, nothing to indicate the occurrence of anything more than a very heavy shower, and had it not been for the steep slope of the country and the narrow outlet of the gulch, which concentrated it, the storm would not have been classed as a cloudburst.

A notable feature of the storm was that it was not accompanied by thunder.

The closing storm of the rainy period reached its greatest intensity about 5 p. m. on the 26th, when the heaviest short downpour in the history of the station occurred. The rainfall amounted to 0.13 of an inch in 2 minutes, 0.23 of an inch in 5 minutes, and 0.26 of an inch in 10 minutes. In the hills, a short distance from the city, the rainfall at this time was very slight.

WINDSTORM AT SEATTLE, WASH.

By G. N. SALISBURY, Section Director.

A sharp wind squall, or, as some considered it, a small whirlwind of a nature resembling a tornado of small intensity and extent, occurred at Madison Park, in the northeast suburbs of Seattle, on the 6th, at about 4 p. m. The disturbance was scarcely over a minute in duration. A black, threatening cloud (several were sure it was a funnel-shaped one) at a height of 25 to 75 feet, swept rapidly down East Madison Street toward the northeast to the lake (Lake Washington) shore at Forty-third and Madison. At the moment of its arrival a wind blast sprung up instantly and blew with violence. Some said the roar of the wind was terrific. No one was killed or injured, but two or three persons were blown down; others saved themselves by clinging to fences, etc. Several trees were broken in twain, and there was much damage to trees and shrubbery in the vicinity. A tower on an old pavilion in the park was blown down; estimated damage $500. The damage to trees, shubbery, etc., in the little park was estimated at $200. A large chestnut tree was broken short off (no evidence of twisting) about half way up at a point about 9 or 10 inches in diameter. A large branch, 6 or 7 inches in diameter, was broken from a sycamore tree, and a large cottonwood tree was broken short off half way up (some 40 feet from ground) at a point 7 or 8 inches in diameter All of these fell toward the north.

At Fortieth and Madison, the Thomas Place, or "Old Homestead," several trees in a yard, full of large trees and shrubbery, were broken off. A large locust was shattered. A fir, or spruce, about 9 or 10 inches in diameter, was broken short off 25 or 30 feet from the ground. Several other trees in the yard were broken off, and many branches of a line of cottonwoods in front were stripped off. Four panels of an old, decayed fence (picket) were prostrated. Everything fell toward the north. A greenhouse of the Washington Floral Co. had many panes of glass broken. At the Hill ostrich farm, Forty-first and Madison, 20 rods of a close boarded fence were prostrated; the fence was old and shaky.

There was to me, when I investigated next morning, no evidence of a whirl, but every evidence of a straight-line squall.